Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 10 *Swine Day (1968-2014)*

Article 568

1994

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Recommended Citation
Richert, B T.; Campbell, R G.; Kershaw, S; Blum, S A.; Goodband, Robert D.; Tokach, Michael D.; and Nelssen, Jim L. (1994) "The effect of lysine and valine fed during lactation on sow and litter lactation performance," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 10. https://doi.org/10.4148/2378-5977.6408

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Abstract

Two hundred two sows (98 parity 1 and 104 parity 2 sows) were used in a 2 x 3 factorial arrangement of treatments to determine the effect of dietary valine and lysine on sow lactation performance. Treatments included two levels of lysine (.8 or 1.2%) and three valine to lysine ratios (80, 100, 120% of lysine). This experiment was conducted at a research farm of a production facility in New South Wales, Australia from January to March, 1994. For all sows, increasing dietary lysine increased litter weaning weight and litter weight gain and reduced sow weight loss. Increasing dietary valine tended to increase litter weight gain. Parity 1 sows had a greater response in litter weight gain to dietary lysine than parity 2 sows. Parity 1 sows also exhibited a linear increase in litter weight gain as dietary valine increased. Parity 2 sows had an increase in litter weight gain at the low lysine level but a decrease in litter weight gain at the high lysine level with increasing valine in the diet. Both parities had a similar reduction in sow weight loss with increasing dietary lysine. The data also were separated into sows that weaned 10 or more pigs and sows that weaned fewer than 10 pigs. Sows that weaned 10+ pigs had a greater increase in litter weaning weight and litter weight gain when dietary lysine was increased from .8 to 1.2 %. These sows also had a linear increase in litter weaning weights and litter weight gain as valine increased. Sows that weaned fewer than 10 pigs had no response to increasing lysine or valine. Serum urea nitrogen was increased by increased dietary lysine but was not affected by valine. The results demonstrate the need to increase dietary lysine and valine as milk production increases. The high-producing sow (10+ pigs weaned) requires increased lysine and valine to maximize litter growth rate and minimize sow weight loss. The independent increases in litter weaning weights from adding lysine and valine suggest separate modes of action in the high-producing sow for these amino acids in milk synthesis.; Swine Day, Manhattan, KS, November 17, 1994

Keywords

Swine day, 1994; Kansas Agricultural Experiment Station contribution; no. 95-175-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 717; Swine; Lysine; Valine; Lactation; Sows

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THE EFFECT OF LYSINE AND VALINE FED DURING LACTATION ON SOW AND LITTER LACTATION PERFORMANCE [1]

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Summary

Two hundred two sows (98 parity 1 and 104 parity 2 sows) were used in a 2 × 3 factorial arrangement of treatments to determine the effect of dietary valine and lysine on sow lactation performance. Treatments included two levels of lysine (.8 or 1.2%) and three valine to lysine ratios (80, 100, 120% of lysine). This experiment was conducted at a research farm of a production facility in New South Wales, Australia from January to March, 1994. For all sows, increasing dietary lysine increased litter weaning weight and litter weight gain and reduced sow weight loss. Increasing dietary valine tended to increase litter weight gain. Parity 1 sows had a greater response in litter weight gain to dietary lysine than parity 2 sows. Parity 1 sows also exhibited a linear increase in litter weight gain as dietary valine increased. Parity 2 sows had an increase in litter weight gain at the low lysine level but a decrease in litter weight gain at the high lysine level with increasing valine in the diet. Both parities had a similar reduction in sow weight loss with increasing dietary lysine. The data also were separated into sows that weaned 10 or more pigs and sows that weaned fewer than 10 pigs. Sows that weaned 10+ pigs had a greater increase in litter weaning weight and litter weight gain when dietary lysine was increased from .8 to 1.2%. These sows also had a linear increase in litter weaning weights and litter weight gain as valine increased. Sows that weaned fewer than 10 pigs had no response to increasing lysine or valine. Serum urea nitrogen was increased by increased dietary lysine but was not affected by valine. The results demonstrate the need to increase dietary lysine and valine as milk production increases. The high-producing sow (10+ pigs weaned) requires increased lysine and valine to maximize litter growth rate and minimize sow weight loss. The independent increases in litter weaning weights from adding lysine and valine suggest separate modes of action in the high-producing sow for these amino acids in milk synthesis.

(Key Words: Lysine, Valine, Lactation, Sows.)

Introduction

Based on recent research conducted by Kansas State University and the University of Minnesota, the valine requirement for lactating sows appears to be higher than the ARC (1981) and NRC (1988) recommendations. Several research trials have demonstrated the benefit of increased protein and lysine in lactating diets for high-producing sows. However, no research has been conducted to evaluate whether the valine requirement is different at higher levels of milk production. Therefore, our objectives were to evaluate effects of increasing lysine and valine on sow and litter performance during lactation and to

[1] Appreciation is expressed to Lonza, Inc. for financial assistance of this trial and to Bunge Meats, Ltd. for their hospitality and assistance in conducting this research trial.

[2] Bunge Meats, Ltd. New South Wales, Australia.

[3] Lonza, Inc., Fair Lawn, NJ.

determine if the response to valine changes as lysine increases in the diet, indicating a similar or additive response between these two amino acids on milk production.

Procedures

Two hundred two sows (98 parity 1 and 104 parity 2 sows) were used in a 2 × 3 factorial arrangement of treatments. Treatments included two levels of lysine (.8 or 1.2%) and three valine to lysine ratios (80, 100, 120% of lysine). The experiment was conducted at a research farm in a production facility in New South Wales, Australia from January to March, 1994. Sow and litter weights were recorded on day 2 postfarrowing after cross-fostering was completed and at weaning. Feed intake was recorded for the entire lactation period. The average lactation length was 23.7 days. Sows were scanned ultrasonically for backfat (BF) thickness at approximately 2.4 inches off the midline on both sides of the body at the 10th rib and last lumbar. There were eight groups of sows with five observations per treatment in each group. The first four groups of sows were bled via vena puncture on day 21 of lactation at 3 hours postconsumption of the initial morning feeding for determination of plasma urea nitrogen (PUN) and plasma creatinine concentrations.

Two basal diets were fed during lactation, one for each lysine level (Table 1). The .8% lysine diet contained .65% valine (80% valine:lysine). The 100% and 120% valine:lysine diets were created by replacing wheat starch in the basal diet with .15 and .30% L-valine, respectively. The 1.2% lysine diet contained .96% valine (80% valine:lysine). The 100 and 120% valine:lysine diets were created by replacing wheat starch with .24 and .48% L-valine, respectively. All .8% lysine diets were formulated to 14.4% CP, 1.0% Ca, and .8% P. All the 1.2% lysine diets were formulated to 20.6% CP, 1.05% Ca, and .8% P. A common gestation diet was fed to all sows following weaning to determine return-to-estrus interval and subsequent litter size (data not reported).

The GLM procedure of SAS was used to determine treatment effects. Days of lactation and litter size after cross-fostering were used as covariates for all data. Initial sow weight and initial sow backfat thickness were used as covariates for sow weight change and backfat change. Because of the increased response observed with the preliminary valine field trial conducted by KSU, the data set was split into two sow groups: sows that weaned 10 or more pigs, and sows that weaned fewer than 10 pigs. It demonstrated a greater response to dietary valine in sows weaning 10 pigs or more. The data also were divided into parity 1 and 2 sows to evaluate any effect of lysine and valine on litter growth rate and sow performance between parities.

Results

All Sows (Table 2). Increasing dietary lysine from .8% to 1.2% increased lysine intake from 35.7 to 55.7 g/day ($P<.001$). The increase in lysine intake increased litter weaning weights ($P<.001$), litter weight gain ($P<.002$), and average weanling pig weight ($P<.006$) and reduced sow weight loss ($P<.001$). Valine intakes ranged from 28.9 g/day on the .8% lysine basal diet to 67.3 g/day on the 1.2% lysine-120% valine diet (linear, $P<.001$). Increasing valine numerically increased litter weaning weight ($P<.27$), litter weight gain ($P<.22$), and average weaned pig weight ($P<.18$) within both lysine levels. Lysine or valine had no effect of sow BF loss.

Sows Weaning ≥ 10 Pigs vs Sows Weaning < 10 pigs (Tables 3 and 4). Two thirds of the sows weaned 10 or more pigs. In this group of sows, litter weaning weight, litter weight gain, and piglet weaning weights increased as lysine increased ($P<.001$) and valine increased (linear $P<.04$, quadratic $P<.08$). Average daily feed intake (ADFI) increased ($P<.02$) by .8 lb for sows fed the high lysine diet. Sow weight loss was reduced ($P<.001$) in sows fed the high lysine diet. Dietary valine had no effect ($P>.17$) on sow ADFI or weight loss. Neither lysine nor valine had an effect on sow BF loss. However, sows that weaned fewer than 10 pigs had no improvement in litter growth rate ($P > .72$) and only a tendency for reduced sow weight loss ($P < .13$) as dietary lysine increased. Sows that weaned fewer than 10 pigs tended to have a quadratic ($P < .13$) response in litter weight gain with increasing dietary valine, with maximum litter weight gain observed at a 1:1 lysine to valine ratio.

All Sows, Parity 1 vs Parity 2 (Data Not Shown). Parity 1 sows had increased litter weaning weight ($P < .005$), litter weight gain ($P < .002$), and average piglet weaning weight ($P < .005$) as dietary lysine increased. Parity 1 sows also had a linear increase in litter weaning weight ($P < .09$) and litter weight gain ($P < .08$) as dietary valine increased. Parity 2 sows had a lysine by valine interaction for litter weaning weight ($P < .08$) and average weanling pig weight ($P < .05$). Parity 2 sows had a linear increase in litter and piglet weaning weights with increasing valine when fed the .8% lysine treatment, but had linearly decreasing litter and piglet weaning weights with increasing valine levels when fed 1.2% lysine. Both parity 1 and 2 sows had reduced sow weight loss ($P < .006$) with increased dietary lysine. Backfat loss was not affected ($P > .40$) by dietary treatment for parity 1 or 2 sows.

Blood Response Criteria (Data Not Shown). Plasma urea nitrogen (PUN) increased ($P < .001$) with increasing dietary lysine. As dietary valine increased, there was a numerical trend ($P < .25$) for reduced PUN. Plasma creatinine concentrations were not affected ($P > .32$) by dietary lysine or valine.

Discussion

The paper reported on page 10 demonstrated the need for increased dietary valine for the high-producing, lactating sow. The present experiment evaluates the valine response at two different lysine levels. Considering the whole data set (Table 2), increased lysine increased litter weaning weight by 9.3 lb, litter weight gain by 8.3 lb, and average weaned piglet weight by .7 lb. The increased dietary lysine also decreased sow weight loss by approximately 20 lb. Similar responses to increased dietary lysine from 35.7 to 55.7 grams/day have been documented in several studies, especially with parity 1 sows. Increasing dietary valine from 80% of lysine to 120% of lysine resulted in one-half of the response to lysine, with litter weaning weights and litter weight gains increasing by 4 lb. The valine response was not as great as that in previous research; however, the valine and lysine requirements appear to be dependent on the milk production of the sow.

Sows that have a greater milk production demand (lactating 10 or more pigs) were responsible for most of the lysine and valine response in this experiment. Sows that weaned 10 or more pigs had a 10 lb increase in litter weight gain with increased lysine and a 7.2 lb increase with increased valine to 120% of lysine. The valine response in sows nursing 10 or more pigs became greater as milk production (as measured by litter weaning weights) increases. For sows fed .8% lysine, valine increased litter weight gain by 4.8 lb at 120% of lysine compared with sows fed the 80% valine. The 1.2% lysine diet had increased litter weight gain of 9.6 lb at the 120% valine level compared with the 80% valine in the high lysine diets. The valine response in the high lysine diet matches the increase in litter weight gain from increased lysine and is additive to the lysine response. Thus, a 20 lb increase (10 lb from lysine and 10 lb from valine) in litter weight gain resulted from feeding the high-producing sow a diet containing high levels of lysine (1.2%) and valine (120% of lysine) compared to sows fed low levels of lysine (.8%) and valine (80 or 100% of lysine). However, sows that weaned fewer than 10 pigs had only a 1.7 lb increase in litter weight gain with increased lysine. The response to valine in sows weaning fewer than 10 pigs tend to be quadratic, with maximal litter weight gain (4.5 lb greater) at a valine level of 100% of lysine. Having the correct valine to lysine ratio in the diet gave a greater response in litter weaning weights than simply increasing lysine in the diet for the sows weaning fewer than 10 pigs. These results indicate that both valine and lysine are required for maximum litter weight gain. Weight loss was 10 (1.2%

lysine) or 20 lb (.8% lysine) greater for sows nursing 10+ pigs than for sows nursing fewer than 10 pigs. Sow weight loss serves as an additional indicator of the difference in the demand for milk production between these two groups of sows. Valine had no effect on sow weight loss. This suggests that the muscle catabolism associated with sow weight loss is to meet the lysine and(or) other amino acid needs of the lactating sow.

Parity 1 sows had significant increases in litter weight gain with increased dietary lysine (11.5 lb) and valine (7.4 lb). However, parity 2 sows had no response in litter growth rate with increasing lysine or valine concentrations. The difference may have been due to parity 2 sows being 90 lb heavier than parity 1 sows, providing more muscle mass from which to draw amino acids for milk production. An additional factor leading to the different responses to lysine and valine may be that the parity 1 sows had a 6.7 lb greater litter weight gain on the high lysine diet and 9 lb greater litter weight gains on the 120% valine:lysine diet than the parity 2 sows. Both parity 1 and 2 sows responded similarly to increased lysine with reduced sow weight loss. Valine had no effect on sow weight loss of parity 1 or 2 sows.

Plasma urea nitrogen increased with increased dietary lysine. Theoretically, PUN should decrease as the sow's amino acid requirements are met. This was the response to increasing valine in this trial; however, it was only a numerical trend. Sows with this level of milk production may not require 56 g/day of lysine, indicating that we may have exceeded the lysine requirement for these sows by feeding a 1.2% lysine diet. This would explain the increased PUN levels with increased lysine. Plasma creatinine levels were numerically lower for both increased lysine and valine; however, these were not significant and may have been due to the high coefficient of variation and difficulty in analyzing several of the samples.

In conclusion, the results of the present trial indicate the need to change dietary lysine and valine levels based on the milk production of the herd. The high-producing sow (and parity 1 sows) weaning 10 or more pigs requires increased lysine intakes (56 vs 36 grams/day) and increased dietary valine concentrations to maximize litter growth rate and milk production. A lower producing sow, however, requires less lysine (.8%) with valine at 100% of lysine to maximize litter growth rate. This trial also indicates that valine and lysine may be acting through different mechanisms in the mammary gland to increase litter weaning weights.

Table 1. Composition of Basal Diets[a]

	Lysine, %	
Item,	.80%[b]	1.2%[c]
Wheat	50.0	39.3
Barley	20.1	19.0
Millmix[d]	10.0	3.5
Wheat starch	1.0	1.88
Expeller soybean meal (44% CP)	11.8	30.8
Tallow	2.7	1.0
Salt	0.5	.5
Limestone	1.0	1.2
Dicalcium phosphate (18% P)	2.2	2.0
Lysine-HCl	.24	.19
D,L-methionine	.07	.17
L-threonine	.15	.21
L-isoleucine	.08	.06
L-tryptophan	.003	.003
L-histidine	.043	.06
Vit. and trace mineral premix[e]	.15	.15
Total	100.0	100.0

[a]Diets were fed for a 23.7 day lactation period.
[b]Valine levels of 80, 100, and 120% of lysine corresponding to .65, .80, and .95% dietary valine were created by replacing wheat starch in the basal diet in .15% increments with L-valine. All three diets were formulated to 14.4% CP, 1.0% Ca, .8% P.
[c]Valine levels of 80, 100, and 120% of lysine corresponding to .96, 1.20, and 1.44% dietary valine were created by replacing wheat starch in the basal diet in .24% increments with L-valine. All three diets were formulated to 20.6% CP, 1.05% Ca, .8% P.
[d]Consisted of mostly wheat midds.
[e]Activity level in grams per ton of feed: 15.0 vitamin A, 3.0 vitamin D3, 80.0 vitamin E, 3.5 vitamin B2, 2.0 vitamin B6, 0.02 vitamin B12, 0.2 biotin, 10.0 pantothenic acid, 0.5 folic acid, 15.0 niacin, 200.0 choline, 86.6 betaine, 1.0 iodine, 0.2 selenium, 20.0 copper, 80.0 iron, 55.0 manganese, 75.0 zinc, 100.0 endox (antioxidant).

Table 2. Effects of Dietary Lysine and Valine on Sow and Litter Lactation Performance: All Sows[a]

	Main effects of treatments					Individual dietary treatments							Probability values			
	Lysine, %		Valine, % of Lysine			.80% Lysine			1.2% Lysine					Valine		
Item,	.80	1.20	80	100	120	80	100	120	80	100	120	CV	Lys	Lin.	Quad.	Lys x Val
Sows per trt	104	98	70	66	66	36	31	37	34	35	29					
Litter WN wt., lb	140.7	150.0	143.8	144.6	147.6	138.6	138.9	144.5	148.9	150.3	150.7	13.8	.001	.27	.73	.74
Litter wt. gain, lb	100.0	108.3	102.8	102.9	106.7	98.7	98.6	102.8	107.0	107.3	110.5	17.3	.002	.22	.50	.99
Litter wt. gain/d, lb	4.61	4.97	4.73	4.75	4.90	4.53	4.55	4.74	4.93	4.94	5.06	17.4	.002	.24	.59	.96
Avg. piglet WN wt., lb	14.4	15.1	14.6	14.6	15.0	14.2	14.1	14.8	15.0	15.0	15.2	11.6	.006	.18	.33	.77
Sow wt. d 0, lb	420.6	419.0	420.1	416.6	422.7	424.3	419.7	417.9	415.9	413.5	427.5	12.8	..83	.78	.55	.58
Sow wt. loss, lb[b]	43.4	24.9	31.1	37.0	34.4	41.7	44.5	44.0	20.6	29.4	24.8	85.4	.001	.53	.35	.84
Initial tenth rib BF, in.	.79	.79	.74	.78	.84	.72	.81	.84	.76	.75	.85	24.2	.81	.01	.68	.34
Initial last lumbar BF, in.	.76	.77	.73	.75	.80	.72	.76	.79	.74	.74	.81	21.2	.74	.02	.58	.75
Tenth rib BF loss, in.[c]	.13	.14	.13	.14	.14	.13	.14	.11	.12	.13	.17	86.8	.40	.52	.88	.20
Last lumbar BF loss, in.[c]	.16	.16	.15	.16	.16	.15	.17	.16	.15	.16	.16	57.4	.96	.71	.46	.97
ADFI, lb	9.8	10.3	10.3	9.7	10.1	10.0	9.6	9.9	10.6	9.9	10.3	19.1	.11	.70	.12	.90
Lysine intake, g	35.7	55.9	46.9	44.3	46.1	36.1	34.8	36.0	57.6	53.8	56.1	18.9	.001	.60	.10	.71
Valine intake, g	35.7	55.7	37.5	44.3	55.3	28.9	34.8	43.3	46.1	53.8	67.3	19.4	.001	.001	.12	.07
No. of pigs WN	9.82	9.94	9.86	9.94	9.83	9.78	9.87	9.81	9.95	10.0	9.85	8.7	.34	.82	.48	.90

[a]Days of lactation used as a covariate. WN = weaning.

[b]Sow weight at d 0 used as a covariate.

[c]Sow initial backfat thickness used as a covariate.

Table 3. Effects of Dietary Lysine and Valine on Sow and Litter Lactation Performance: 10 or More Pigs Weaned/Litter[a]

	Main effects of treatments					Individual dietary treatments							Probability values			
	Lysine, %		Valine, % of Lysine			.80% Lysine			1.2% Lysine					Valine		
Item,	.80	1.20	80	100	120	80	100	120	80	100	120	CV	Lys	Lin.	Quad.	Lys x Val
Sows per trt	66	67	45	45	43	22	20	24	23	25	19					
Litter WN wt., lb	147.6	159.0	151.4	149.1	159.0	145.8	143.5	152.7	157.0	154.6	165.3	11.4	.001	.04	.06	.98
Litter wt. gain, lb	105.3	115.3	109.0	105.6	116.2	104.8	101.4	109.6	113.2	109.8	122.8	14.5	.001	.04	.02	.73
Litter wt. gain/d, lb	4.84	5.29	5.01	4.87	5.33	4.81	4.68	5.04	5.20	5.06	5.63	14.6	.001	.04	.03	.76
Avg. piglet WN wt., lb	14.1	15.1	14.3	14.3	15.2	13.8	13.8	14.7	14.9	14.8	15.8	10.9	.001	.01	.08	.98
Sow wt. d 0, lb	420.0	420.3	421.5	417.7	421.3	423.9	414.9	421.2	419.0	420.5	421.3	12.0	.97	.98	.70	.89
Sow wt. loss, lb[b]	51.0	28.5	36.8	40.4	42.0	47.2	51.8	54.0	26.5	29.0	30.0	70.5	.001	.39	.85	.96
Initial tenth rib BF, in.	.80	.81	.75	.82	.84	.73	.84	.82	.76	.80	.85	23.9	.80	.03	.43	.67
Initial last lumbar BF, in.	.76	.77	.72	.78	.80	.71	.78	.78	.73	.78	.82	21.3	.48	.03	.56	.90
Tenth rib BF loss, in.[c]	.16	.16	.16	.16	.15	.18	.17	.12	.15	.15	.18	73.3	.82	.60	.87	.11
Last lumbar BF loss, in.[c]	.17	.17	.17	.17	.17	.17	.17	.17	.16	.16	.18	53.4	.68	.77	.71	.84
ADFI, lb	9.7	10.5	10.1	9.8	10.4	9.7	9.3	10.1	10.5	10.3	10.7	18.2	.02	.38	.17	.90
Lysine intake, g	35.1	57.1	46.1	44.8	47.5	35.0	33.8	36.7	57.2	55.8	58.2	18.3	.001	.46	.20	.99
Valine intake, g	35.3	57.1	36.8	44.8	56.9	28.0	33.8	44.1	45.7	55.8	69.8	18.6	.001	.001	.19	.11
No. of pigs WN	10.49	10.50	10.57	10.46	10.46	10.60	10.44	10.43	10.54	10.48	10.49	4.7	.84	.29	.57	.85

[a]Days of lactation used as a covariate. WN = weaning.

[b]Sow weight at d 0 used as a covariate.

[c]Sow initial backfat thickness as a covariate.

Table 4. Effects of Dietary Lysine and Valine on Sow and Litter Lactation Performance: Less than 10 Pigs Weaned/Litter[a]

	Main effects of treatments					Individual dietary treatments							Probability values			
	Lysine, %		Valine, % of Lysine			.80% Lysine			1.2% Lysine					Valine		
Item,	.80	1.20	80	100	120	80	100	120	80	100	120	CV	Lys	Lin.	Quad.	Lys x Val
Sows per trt	38	33	26	21	24	14	11	13	12	10	11					
Litter WN wt., lb	129.1	130.9	130.0	134.1	125.9	128.9	129.5	129.0	131.1	138.7	122.8	14.0	.87	.72	.18	.40
Litter wt. gain, lb	91.5	93.2	91.9	96.4	88.8	90.8	93.0	90.6	92.9	99.7	87.0	17.5	.92	.87	.13	.56
Litter wt. gain/d, lb	4.21	4.30	4.24	4.45	4.07	4.18	4.28	4.16	4.30	4.62	3.97	17.4	.83	.72	.11	.51
Avg. piglet WN wt., lb	14.9	15.0	15.0	15.2	14.6	14.9	14.9	15.0	15.1	15.5	14.2	12.8	.77	.76	.39	.45
Sow wt. d 0, lb	420.6	416.4	417.0	413.5	424.9	424.1	429.0	408.8	410.0	398.0	441.0	14.4	.78	.66	.64	.21
Sow wt. loss, lb[b]	29.7	18.0	21.8	30.4	19.2	33.8	28.8	26.4	9.8	32.1	12.1	125.9	.13	.78	.22	.34
Initial tenth rib BF, in.	.78	.73	.74	.68	.85	.72	.76	.87	.75	.61	.84	24.8	.29	.04	.03	.26
Initial last lumbar BF, in.	.76	.74	.75	.69	.80	.74	.74	.79	.77	.65	.80	21.0	.65	.38	.06	.46
Tenth rib BF loss, in.[c]	.08	.10	.08	.08	.12	.06	.08	.10	.09	.08	.14	123.7	.47	.24	.54	.79
Last lumbar BF loss, in.[c]	.13	.14	.13	.16	.12	.12	.15	.12	.14	.17	.12	64.1	.59	.67	.21	.79
ADFI, lb	10.1	9.7	10.5	9.6	9.6	10.5	10.2	9.6	10.6	9.0	9.6	22.5	.26	.42	.56	.67
Lysine intake, g	36.6	51.7	46.0	42.8	43.7	38.1	36.8	35.0	53.9	48.9	52.5	23.0	.001	.45	.45	.66
Valine intake, g	36.4	51.6	36.8	42.9	52.3	30.6	36.9	41.6	43.1	48.9	62.9	22.2	.001	.001	.51	.19
No. of pigs WN	8.65	8.75	8.65	8.82	8.62	8.61	8.74	8.60	8.70	8.91	8.64	5.3	.37	.81	.13	.90

[a]Days of lactation used as a covariate. WN = weaning.

[b]Sow weight at d 0 used as a covariate.

[c]Sow initial backfat thickness used as a covariate.